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Beamlet Schlieren Diagnostic and Experiments

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ABSTRACT

Background

Historically, the standard diagnostic suite on a high-power solid-state laser system such as Nova or Beamlet has been near field imagery, energy calorimetry and time resolved power measurements. ICF laser performance relies requires not only measurement of these quantities, but additional knowledge of beam focusability. Without phase information, the near field is inadequate to address focusability issues. The extreme dynamic range present in focal spots makes these images difficult to acquire. This paper details the diagnostic installed on the Beamlet laser to characterize the 1.053 micron (1ω) beam focal characteristics and reports the results of the experimental campaign to determine focal parameters of the Beamlet 1ω beam. Since the focusability of the frequency tripled (3ω) output of the beamlet laser depends strongly on the properties of the 1ω beam, this was a necessary first step in understanding 3ω focusability issues.

A Schlieren experiment is one traditional method of obtaining data on the focal spot over a wide dynamic range. Sometimes referred to as "dark field images", Schlieren data is taken by blocking the central lobe of the focal spot. Portions of the beam whose divergence is larger than the angle subtended by the Schlieren block are collected and analyzed. By imaging the Schlieren data in the near and far fields, spatial frequency content and areas contributing to high angle scatter are determined.

Diagnostic Design

Instead of a conventional Schlieren obscuring block, the Beamlet diagnostic was designed to use a scraper mirror to separate the central focal lobe from the higher angle scattered intensity. After a sample of the incident beam from a splitter was collected in energy and power sensors, the beam was focused onto a spherical mirror which had a small diameter hole drilled through the center. Light passing through the hole was monitored by a low resolution CCD camera as an alignment aide and collected in energy and power sensors for use in energy balance calculations. Light reflected from the Schlieren mirror was collected onto cameras imaging both the far field and near field and onto energy and power sensors. The angular acceptance of the diagnostic was ±800 microradians.

Shot series

The Schlieren experimental campaign was conducted under circumstances approximating the last 200 ps of a much longer, more energetic beam. For this series, Beamlet was operated at 200 ps with the booster amplifier not fired, simulating the effect of passing through a heavily saturated amplifier. This

resulted in high B-integral values for relatively low risk conditions of fluence and energy.

Over 70 shots were taken including activation shots. These shots consisted of rod shots, low energy system shots and high energy system shots. Due to the limited amount of time available no mid-range energy shots were attempted. Three different size Schlieren blocks (in this case, holes in the Schlieren mirror) were used: ±20, ±33, and ±66 microradians.

The results of the experimental series will be presented.

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